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EXTREME ULTRA-VIOLET EMISSION FROM CORONAL LOOP STRUCTURES, (U)

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by

W. H. Tucker

July 1980

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XUV EMISSION FROM CORONAL LOOP STRUCTURES

W.H. Tucker

I. INTRODUCTION

I summarize here calculations of the XUV spectra of coronal loop structures. The objective is to provide a framework for distinguishing between loop model parameters such as the heat input to the loop and the geometry of the loop, and thereby set a baseline for the model calculations for the microwave radio emission.

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II. METHOD

The spectrum of a coronal loop is primarily a line spectrum emitted by a gas having a wide range of temperatures and densities. The gas can to a good approximation be treated as optically thin in these lines, so for any line of wavelength λ from an ion X_i of element X, the power in the line is

$$P_{X_i}(\lambda_i) = \int_{s_0}^{s_{\max}} P_{X_i}(\lambda_i, T(s)) N_e^2(s) A(s) ds \quad (1)$$

where $P_{X_i}(\lambda_i, T(s))$ is the power in the given line as a function of the temperature T , which will in general depend on the distance s along the loop; $N_e(s)$ is the electron density as a function of distance along the loop, and $A(s)$ is the cross-sectional area of the loop. Since T is a unique function of s , we can re-write equation (1) as an integration over T :

$$P_{X_i}(\lambda_i) = \int_{T_0}^{T_{\max}} P_{X_i}(\lambda_i, T) \xi(T) dT \quad (2)$$

where

$$\xi(T) = \frac{N_e^2 A}{(dT/ds)} \quad (3)$$

is the differential emission integral.

To compute the emission line intensities, I used the calculations of Raymond (1980) for the $P_{X_i}(\lambda_i, T)$ and the calculations of Vesecky, Antiochos and Underwood (1979) for model loops. They considered a quasi-static model with a uniform energy input per unit volume, ϵ , and loop configurations which represent approximately that to be expected from plasma confined by the field of a bipolar active region.

Their calculations show that the loop can be divided into three regions: (1) the low temperature base of the loop, isothermal up to

fractional distances of 10^{-6} along the loop; (2) the legs of the loop, in which the differential emission measure varies slowly along the loop; (3) the upper ten to fifteen percent of the loop, which is isothermal at the maximum temperature of the loop.

In region (1), I use equation (1), which becomes

$$\left(P_{X_1}(\lambda_i) \right)_1 = P_{X_1}(\lambda_i, T(s_1)) N_e^2(s_1) A(s_1) \Delta s_1 \quad (4)$$

For region (2), I use equation (2), and evaluate the integral numerically using Simpson's rule. For region (3), an expression similar to (4) is used:

$$\left(P_{X_1}(\lambda_i) \right)_3 = P_{X_1}(\lambda_i, T(s_3)) N_e^2(s_3) A(s_3) \Delta s_3. \quad (5)$$

The emission in broad bands of wavelength is calculated in the same way as the emission lines, using the calculations of Stern, Wang and Bowyer (1978) and Kato (1976) for broad band spectra in the range 1-1000 Å.

III. RESULTS

The expected intensities of several important XUV lines are given in Table 1 for four variations of the Vesecky et al. (1979) model. The ratio of the intensities of any of the lines He II (304A), CIV (1550A), OIV (789A), OV (630A), OVI (1034A) to that of SiXII (499A) would appear to provide a clear distinction between the different model loops. The ratio of the intensities of the helium-like to the hydrogen-like ions of oxygen, OVII (21.6A) / OVIII (19A) is sensitive to the heat input, but not the geometry of the loop.

As expected, the models with more material at high temperatures ($\Gamma = A_{\text{top}}/A_{\text{bottom}} = 50$) produce a harder broad band spectrum (see Figure 1).

IV. FUTURE WORK

Plans for the immediate future include the calculation of $\Gamma = 50$ loop models and a comparison with observed line intensities.

V. ACKNOWLEDGMENT

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- Raymond, J. 1980 (private communication)
- Stern, R., Wang, E. and Bowyer, S. 1978, Ap. J. Suppl. 37, 195.
- Vesecky, S., Antiochos, S. and Underwood, J. 1979, Ap. J. 233, 987.

TABLE 1
 Percent Fractional Power in Selected Emission Lines
 $(100 \frac{P_{\text{Line}}}{P_{\text{total}}})$

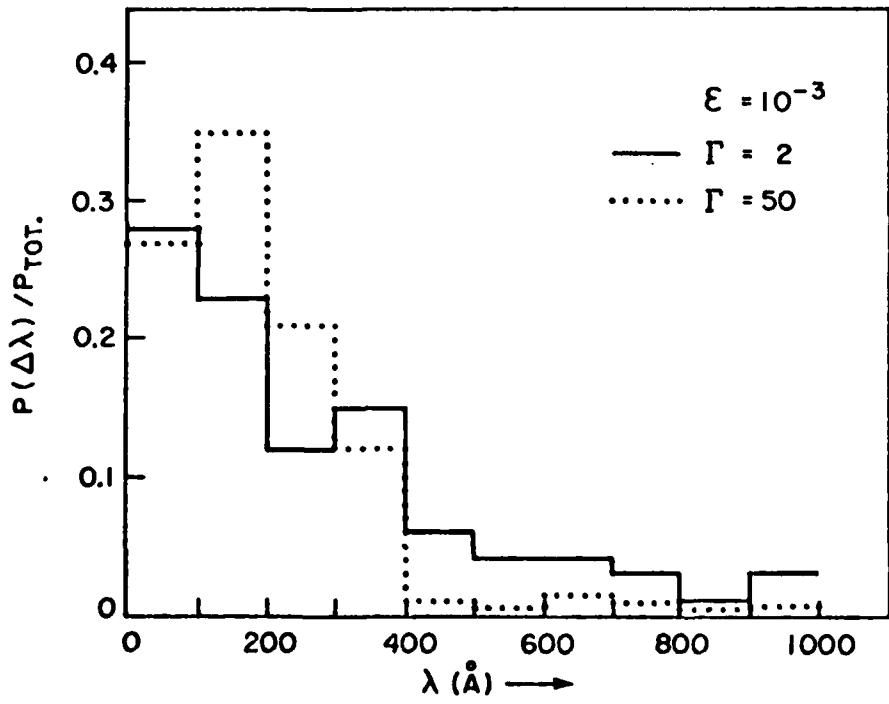
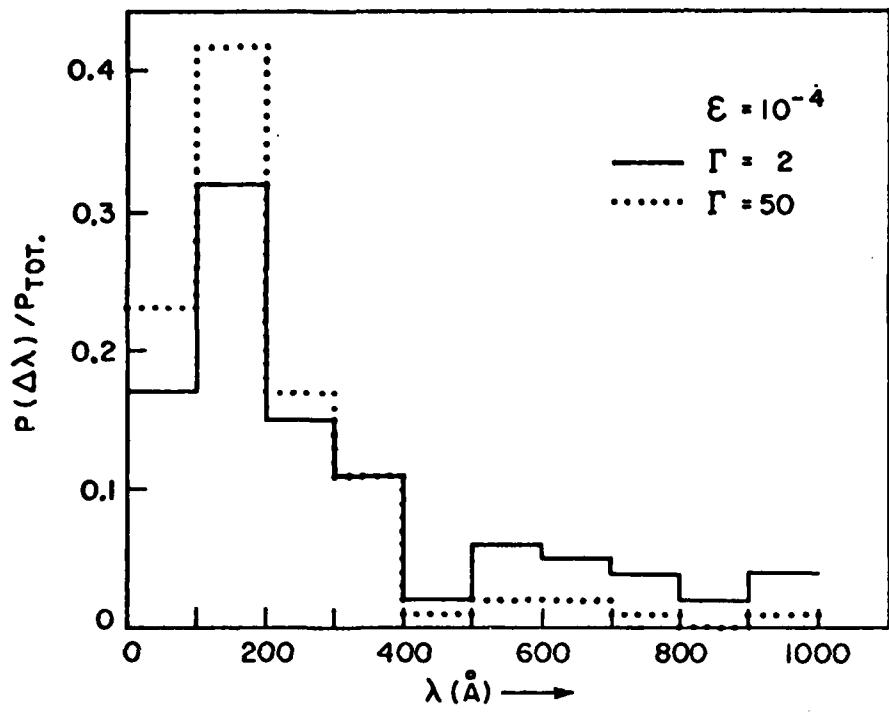
Model Line	$\epsilon = 10^{-4}$ $\Gamma = 2$	$\epsilon = 10^{-4}$ $\Gamma = 10$	$\epsilon = 10^{-3}$ $\Gamma = 2$	$\epsilon = 10^{-3}$ $\Gamma = 10$
HeII(304A)	2.8	1.0	1.7	0.6
CIV(1550A)	1.4	0.51	0.8	0.3
OIV(789A)	3.1-	1.2	1.9	0.7
OV(630A)	7.4	2.9	4.6	1.6
OVI(1034A)	5.4	3.9	3.8	1.9
MgX(615A)	0.65	1.60	0.51	0.6
SIXII(499A)	0.05	0.13	1.1	1.8
FeXVI(335A)	--	--	0.96	1.5
OVII(21.6A)	0.54	1.18	1.61	2.74
OVIII(19.0A)	0.03	0.07	1.49	2.3

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FIGURE CAPTION

Figure 1. Broad band XUV spectra for a range of model loop parameters.



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